ENGINEERING NEWS.

Tribune Building, New York City.
GEO. H. FROST, PROPRIETOR.

SATURDAY, FEBRUARY 5, 1881.

WORK is progressing favorably at the Hudson River Tunnel. The south tunnel has been completed for a distance of two hundred and twenty-five feet from the shaft. Four and one-half feet of completed tunnel is the average result of a day's work.

AS THE eager, frowsy throng within the railings of loud-smelling courtrooms, or the noiseless, melancholy activity of undertakers' warerooms betoken "good times" among our brethren of the "learned" professions, so does the cheerful, busy hum of lathe and planer and drilling-machine in the shops of the transit and level makers indicate, to a certainty, the prosperity of the profession which exists only to link all nations together in the peaceful rivalry of trade and commerce, which never tears down except to rebuild in better shape, and whose single aim in life is to leave the world healthier, happier and richer in "improvements" than it finds it. Some weeks ago, in passing through Philadelphia, we spent a pleasant interval in the crowded shops of Messrs. Heller & Brightly and Wm. J. Young & Sons, so long and favorably known for the excellence of their manufactures and their enterprise in advertising them. The demand for shop room had finally reduced the office of the lively and loquacious Heller to a space about as wide as himself, where he was hidden behind a pile of home and foreign stamped letters that would make a "collector" go wild with envy, and from the serious examination of which he hadn't time to spare for even one entertaining reminiscence. The shops were about as full of men and machinery as the combined mathematical talent of the firm could discover space for. Since then so many new railroads have been projected that Heller's linguistic attainments have given out, together with time and space, and hence the advertisement which we publish elsewhere this week.

We spent a profitable hour with Mr. Young, whose shop facilities for filling his daily increasing orders from "the uttermost parts of the earth" were becoming quite as much of a puzzle as was the similar problem to his closely adjacent rivals. We had already heard much of the celebrated dividing engine of this old established firm, and so were especially pleased to see it at work, and learn the history of its construction from Mr. Young, who assisted his father through the many years that he was engaged on this marvel of precision in instrument manufacturing.

If we may judge from our correspondence, the leading makers of engineers' instruments, who are also the principal advertisers in the engineering and railway journals, have the most happy exhibits in the way of well-filled order books, and in this pleasing circumstance they and the profession which they serve may exchange congratulations after the memory of the lonesome experiences of some of the past seven years.

THE NORFOLK (VA.) WATER-WORKS.

Norfolk, Va., has had a rather remarkable experience in the matter of its water supply. Some seven years ago the Holly Manufacturing Co. constructed the works in that city, furnishing a quadruplex engine and rotary pumps of the pattern which they were building at the time, the machinery having a capacity of some three million gallons daily—an ample amount obviously for a population numbering not much over 25,000 souls. After using the apparatus for about five years, the Norfolk authorities decided that a still greater supply was required. Their engineer was sent North to make arrangements for the same, and that gentleman, after consultation with the firm of H. R. Worthington, arrived at the conclusion that the interests of the city would be best subserved by the replacing of the Holly machinery by a Worthington pump of similar capacity, adapted to deliver water, according to the Holly system, directly into the mains.

The city thereupon contracted with Mr. Worthington for a new duplex pump, provided facilities for its establishment, and, as we are informed, allowed Mr. Worthington to offer the Holly machinery for sale at a comparatively nominal price.

This condition of affairs coming to the attention of the New York representatives of the Holly Company, Messrs. Park, Benjamin & Bro., those gentlemen at once proceeded to investigate the matter. They discovered that so far from the Holly machinery in Norfolk being in anywise deficient, it was in remarkably good condition, considering the severe and unlooked-for usage to which it had been subjected, the extent and nature of which those familiar with the system may judge from the fact that the engineer had run the machinery entirely without the use of the automatic regulator, constantly from the time of its establishment. Although he had manifestly erred in this proceeding, on the other hand, the admirable appearance of the apparatus otherwise betokened skilled care.

Meanwhile, a second decision affirming the rights of the Holly Company to the direct system of water supply covered by their patents had been rendered by Judge Wheeler in the U. S. Circuit Court of Vermont. Norfolk consequently stood in something of a quandary. It was evident that with comparatively small repairs and with proper use of the regulator, the Holly machinery was ample to supply all needs. Furthermore, it appeared that to use the Worthington pump, as contemplated, would be to infringe the Holly patents, and the Holly Company lost no time in giving the city notice to that effect. Yet there was the Worthington apparatus contracted for, besides a million gallon pump of the same sort already purchased and in operation. To run all this plethora of machinery and thus give each inhabitant of Norfolk a maximum daily supply of *two hundred and twelve gallons* of water, would be rather too much of a good thing, not to mention the needless expenses and the probability of litigation so incurred.

The city sought to shift the burden elsewhere by requesting Mr. Worthington to give a bond indemnifying it against any action of the Holly Company, based on the use of his pumps on the direct system, but this he declined to do. Finally, after consultation with eminent counsel, Norfolk declared itself ready to treat with the Holly Company, and that concern at once offered to put its engine in thorough condition, and to allow the use of the Worthington pumps as an auxiliary, or reserve, for a moderate sum, which terms were at once accepted.

The Holly system therefore remains, as hitherto, the principal means of water supply of Norfolk, with the Worthington pumps as reserve, unless the latter be otherwise disposed of. The Holly Company now propose to subject their engine as soon as the repairs are furnished, and also the new Worthington pumps intended to replace it, to a rigid duty trial by impartial engineers, in order to determine the relative efficiency of the two forms of apparatus, working, as it happens, under like conditions, giving their competitor the benefit of his new machinery as against theirs, constructed on a model of seven years ago. Whichever way this test comes out, it will be interesting reading to engineers, and an early announcement of the results may be looked for in these columns.

ENGINEERING ABROAD.

[From our own Correspondent.]

PARIS, Jan. 19, 1881.

To sit in a crowded theatre, and yet find it pleasant and cool, has been hitherto considered as one of those unattainable comforts which we are always striving after. Yet those who have been in the Vienna Opera-house are enthusiastic in praise of the system of

VENTILATION AND HEATING,

introduced by Dr. Boehm. One of the members said at the recent meeting of the Société des Ingéneiurs Civils de Paris: "I was in Vienna in July; the heat was most oppressive, but I both cooled and rested myself in the Opera." This result is so important and unexpected, that a full description of the plan adopted in the Vienna Opera-house will be of interest. The report was sent in by Messrs. Herscher and Demimuid. The great point which has been hitherto practically lost sight of was to bring pure air to the consumer, and to withdraw the vitiated air at the same time. What used to be done was simply to envelope the audience with heated air. But the scientific system is to heat the atmosphere outside the circular wall, and then let this heated air be drawn naturally into the apartment, and thus form a self-regulator. Circular passages, or *couloirs*, form, as it were, an overcoat to the hall. The air is not heated inside the theatre, but there is a sufficient ventilation of moderately heated air from without. So far as the vitiated air is concerned, it has a natural tendency to escape by the roof.

The opera building is 121 meters in length and 92 in width, covers 8,000 square meters and can seat 2,700 persons. The hall is illuminated by a chandelier of 90 lights and a luminous crown of 16 reflectors, each with a group of 25 burners. The reflectors are grouped around the opening of the chandelier.

The ventilation is secured by two ventilators, one an "insufflator" which is established in the lower part of the building, and the other a suction ventilator placed in the main chimney, above the chandelier. The motion of the air which is thus produced in the hall is upward, and is greatly increased by the draught of the heat of the chandelier and reflectors in the ceiling. The caloric contributed by the audience still further accelerates this upward motion of the bad atmosphere, which escapes by the vent in the chandelier. The pure air in the garden of the theatre is heated by steam, and is admitted into the hall at a temperature of 17° or 18° C., or about 66° F. through the flooring of the parquette, and through the the lower parts of the boxes and galleries.

The upper gallery receives the air through the bottom of the seats, which are perforated and provided with very fine screen work. During very warm weather an extra supply of cool fresh air is forced into the hall by apertures all round the ceiling. The passages also receive a certain amount of air from the heating rooms underneath. The escape holes, which supply the air, are near the spectators, and are furnished with fine screen work, which pass the air, as it were, through a sieve, and prevent the slightest feeling of a draught. The air enters at the rate of 0.30 m. per second.

The supply ventilator gives 110,000 cubic meters of air per hour, but the usual quantity is from 80,000 to 85,000 meters, or about thirty cubic meters for each person. The same movement is transferred by a belt to the section ventilator. The method of introducing the air is as follows: Two air-holes are arranged in the gardens, each about 6 meters by 4 meters. From these the air passes into a subterranean reservoir, 7.50 meters in height, and here, in the summer season a spray of cold water is continually falling, thus bathing and cooling the air. The propelling or supply machine

can, of course, be regulated to any number of turns, and so the quantity of air can be regulated according to the season. The conducting canal is 2.40 meters in diameter, but enlarges to 3.50 at the ventilator; it communicates under the parterre with a space equal to that of the hall and passages. It is divided into three floors, one above another. The lower one receives the air coming from the ventilator, and is divided into chambers corresponding respectively to the parquette, boxes and galleries—each division having a special register for regulating the entrance of the air. The intermediate floor, which is similarly arranged, has independent heating apparatus for each division. The heating surface is formed of 18,000 meters of drawn iron pipes—35 millimeters in interior diameter. The upper floor, which is directly under the parquette, has mixing rooms.

The cold air can penetrate directly from the bottom to the upper floor of the basement by means of vertical cylindrical pipes 0.95 m. in diameter, and which cross the middle floor. The middle floor is in communication with those above and below, by means of annular openings which are concentric to the above pipes. Cold or warm air is admitted by means of iron bells, arranged above the pipes. An ingenious contrivance allows these bells to be lowered or raised at will, and independently for each series of chambers. As the mixing room is immediately under the orchestra and parquette, the temperature of each seat can be regulated. The arrangement for heating the boxes is not nearly so good, the air being taken from the passages by openings in the lower part of the doors. The passages contain openings or feeders, in addition to the normal openings.

The vitiated air of the boxes and lower galleries ascends to the ceiling and escapes by the chimneys of the chandeliers and reflectors, but special air pipes are placed in the ceiling of the upper galleries. A central chamber over the chandelier receives all the vitiated air, and a chimney 4.10 m. in diameter, surmounted by a movable cap, allows it egress. A system of electric thermometers corresponding with the different parts of the building enables the engineer to regulate the supply of air and heat in every corner of the building. The system is now being adopted in every European capital, and has been recognized as the only true solution of the problem.

EXPLOSIVE GELATINE.

This substance is highly spoken of by engineers, who believe that it saves 20 per cent. in cost of labor and 15 per cent. in rapidity of work. The Saint Gothard experiences have been very conclusive, so much so that the engineer of the great work, M. Bossi, sent a certificate to M. Nobel, the inventor. With ordinary dynamite the work at Airolo required 4.28 kilos. of explosive per cubic meter, and 2 kilos. for rubbish. With the gum the quantity of explosive was only 2.80 kilos. for blasting, and 1.02 for the rubbish; besides only 0.17 of priming was necessary, as against 0.300 for the ordinary dynamite. In fact a new series of explosives will be formed of various proportions of the binary powders, mixed with explosive gelatine. But although dynamite No. 1 may be thrown into the shade, it has been shown that its explosibility, is not so dangerous as commonly believed. A thin piece of wood has prevented any effect from a rifle ball fired at a very short distance. The proportionate strength of the various explosives may be fixed as follows: That is, to produce the same effect, these quantities are necessary :

Dynamite gum	1.
Nitro-glycerine	1.10
Dynamite No. 1	1.50
Dynamite Nos. 2 and 3	2.15
Common black powder	4.50

A NEW SURVEY OF FRANCE—A NEW LEVEL.

The French government has ordered a new survey, which it is thought will furnish some interesting materials to science, with regard to changes of surface. All methods in which the weight of the air is used are to be rejected, as errors of 10 meters are inseparable from them. Geodesic methods are not so suitable in thickly populated plains. The geometric surveys of M. Bourdaloue have been exceedingly well carried out owing to his own personal skill. It is now proposed to use the surveys of the rivers and railroads, and to employ a new level, which can be lengthened at will. This level is composed of two air-glass tubes, connecting with an india-rubber tube, which extends over the entire distance between the two levels taken. The tube is 500 meters in length, and the air-tubes 1m. 80 in height. It is certainly cumbersome, and when carried by rail will require wagons 600 meters in length.

THE INUNDATIONS AND ENGINEERING.

Holland, whose very *raison d'être* may be considered as connected with engineering, is again anxious about its dikes. Hungary, Spain, Italy and France are also in dread of more loss from inundations. The disaster at Szegedin and Murcia are still fresh in our recollection. How to remedy this constant danger is the great engineering problem. The system of wooding the countries is not practicable, nor perhaps would it even be successful. The system of longitudinal embankments has never proved entirely satisfactory. A system of dams, and a hydraulic stairway with immense reservoirs for storm waters is thought to be the only successful way of meeting the difficulty.

The wet weather is causing a great deal of annoyance, at least to some. Iron roofs are caving in, and only last week a beton cement bridge at Dusseldorf quietly subsided. Yet the material was found good, but the percolation, aided, it is said, by the trees in the neighborhood, was too much for the structure.

LIGHTING THE GOTHARD.

The fifteen kilometers of the St. Gothard tunnel would require 1,200 electric lamps and 40 batteries to properly illuminate it. A second plan has been spoken of, viz., to have a movable electric locomotive. Gas evidently is not the thing, and the electric light has here become a necessity.

PERSONAL.

Mr. R. Bell, who has, for the past eight years, been the Assistant Engineer on the Susquehanna Division of the N. Y., L. E. & W. R. R., has been appointed Chief Engineer of the Genesee Valley Canal Railroad Company, with office at Mt. Morris, N. Y.

Messrs. R. Kanters & Son, harbor contractors, of Holland, Mich., recent contractors for protection works at Lincoln Park, Chicago, have located at Velasco, Brazoria Co., and at Indianola, both in Texas, where they have the contracts for deepening the channels at the Pass Cavello and the mouth of the River Brazos, both under the direction of Major S. M. Mansfield, U. S. Engineers. These works are of considerable local importance and are the first appropriation to be expended in that vicinity.

Mr. Charles Devlin, a prominent contractor of this city, died on Tuesday, of pneumonia, at the age of 75 years. Originally a baker, his first great success as a contractor was on the Hudson River Railroad. After that he became a contractor for the construction of sewers for the city. He also did the greater part of the heavy grading and rock cutting in Central Park when it was laid out some years ago.

A suit of Mr. Devlin against the city, arising out of a sewer contract, in which the claim is for $457,000, is still pending in the courts.

James E. Childs, late General Manager of the Rochester & State Line Railroad, was appointed General Superintendent of the Ontario & Western Railroad on the 29th ult., with headquarters at Middletown, to take effect Feb. 1. N. R. Hankins remains Superintendent of the middle division, and C. W. Lamphere of the northern division. Vice-President Theodore Houston remains General Manager, having special charge of the construction of the connecting line from Middletown to New York. The office of General Superintendent has been vacant since the death of Henry M. Flint several years ago.

Herman W. Luders, a mechanical engineer and chief draughtsman at the Pennsylvania Steel Works, Dauphin County, died on the 29th ult., in the University Hospital, Philadelphia, from self-inflicted injuries while suffering from malarial fever. On Thursday, 27th, he started to come to that city to visit his brother, and induced a friend to accompany him from Harrisburg. Some time after the train left Dowington he was found at the end of a car, in a pool of blood, with his throat cut. His previous actions indicated that he was demented. Luders was in good circumstances, held a responsible position, and was highly respected.

A party of civil engineers arrived in this city on the *Rio Grande* Sunday, and will leave by steamer to-day for the West. Their destination is Laredo, on the Rio Grande, from which point they will at once proceed to survey a railroad line to the City of Mexico. The party consists of Captain Charles H. Patterson, chief engineer; Captain J. W. Pratt and R. R. Harrison, of West Virginia; Stanley M. Jones, of New York; E. Trego, of Philadelphia; J. F. Perez, of New York; E. L. Crawford, of Baltimore; F. W. Sargent, Philadelphia; F. Porter, of Pittsburgh; H. Leaf, of Pottstown, Pa.; George L. Van Zandt, of Philadelphia, and R. Meyer, of New York. They go to the front prepared and equipped for full and complete work.—*Galveston News, Jan. 25.*

CORRESPONDENCE.

HENCK'S FIELD BOOK.

630 FOURTH STREET, S. E., MINNEAPOLIS, Minn., Jan. 25, 1881.

I would call your attention to the fact that, although all the "errors in Henck's Field Book," published in the several letters in ENGINEERING NEWS, occur in the edition of 1869, they are all corrected in the edition of 1879. I presume that the latter edition was printed from the same plates corrected. Yours truly,

ELBERT NEXSEN.

HISTORY OF AMERICAN WATER-WORKS.

PITTSBURGH, Pa., Feb. 1, 1881.

EDITOR ENGINEERING NEWS:

I want a copy of the proposed paper on water-works, by J. J. R. Croes. Am I to understand there is something to pay in addition to the subscription to ENGINEERING NEWS?

Respectfully, J. H. H.

[The "proposed paper" above alluded to will take one year to publish, at the rate of two pages per week, in ENGINEERING NEWS. There will be no extra charge.—ED. ENG. NEWS.]

CITY OF HOLYOKE, MASS., OFFICE OF THE WATER COMMISSIONERS, Jan. 31, 1881.

EDITOR ENGINEERING NEWS:

I gladly contribute my mite to "The History of American Water-Works," and send you a complete set of our reports, excepting last year's, which I will forward as soon as printed.

Your undertaking is commendable, and its announcement should result in a prompt response from every water-works officer in America.

Any special information not contained in report I will cheerfully furnish.

Yours truly, E. P. CLARK, Registrar.

[We publish Mr. Clark's very courteous letter

for the purpose of stimulating the superintendents, registrars and engineers of water-works to follow his example. Mr. Croes is busily engaged in classifying his materials for the work in hand; we have not yet sent out any circulars, and do not wish to until it is unavoidable. We therefore solicit an early and prompt response to our request for such water-works statistics as are available. The work is a very important one, and we wish to create a lively interest in its progress among our patrons, who certainly are very much interested in its completeness.—ED. ENG. NEWS.]

THE GROVELAND BRIDGE DISASTER.

CLEVELAND, O., Jan. 27, 1881.

EDITOR ENGINEERING NEWS:

The quotation from the Newburyport *Herald* of April 11, 1872, in your issue of Jan. 22, 1881, concerning the Groveland bridge, is incorrect in at least one particular.

I did not design the arch spans of the bridge referred to.

I had nothing whatever to do with the making of the specifications.

Yours truly, C. G. FORCE.

HERE AND THERE IN MEXICO.

MEXICO CITY, Jan. 17.—In the course of a fortnight the submarine cable which is to place Mexico in communication with the United States and Europe will be completed. Hitherto there have been disagreeable delays with regard to telegrams because the only line, via Matamoras, was not continuous, and the transmission of a message to New York was often an affair of seven days. In some instances telegrams from Washington to Mexico City have been nine days en route. By the 1st of February we can obtain news from the United States in fifteen minutes.

The rapid advance of the Central Railroad continues. Its chief, Mr. R. Symon, is out on or near the Pacific coast, but he has selected his representatives and assistants so judiciously that the whole enterprise is progressing admirably.

We have met some of the Central company in society, and were gratified to find that these intelligent, gentlemanly civil engineers were highly respected by Mexicans as "representative Americans."

El Nacional of the 15th inst. contained an article on the Tehauntepec Railroad, in which Señor Don Francisco Sosa states that the opposition of certain Mexican speculators, who reside on the isthmus or own property there, has created many difficulties and greatly retarded the completion of the work.

Favorable news has been received here with regard to the Eads surveying party, who had arrived at Minatitlan in good health and spirits, and were pressing forward to commence the new survey.

This government has also commissioned Captain Eads to examine the Tampico "bar" and give his opinion as to the means necessary to be employed for the improvement of that port.

The Palmer-Sullivan Railway, from Mexico City to Toluca (capital of this State) will be finished in July, possibly earlier. The entire survey was completed last month. The road-bed is far advanced, and laborers will soon commence putting down the rails.

During the past three months Mr. Sullivan has obtained two more concessions—that of Michoscan and the route from Zacatecas to Guadalupe. A section of the latter was already completed, and this Sullivan purchased on the 14th instant, for $300,000.

The Palmer-Sullivan Company have also obtained the right to construct a suburban railway which will connect the Cautitlan road with the tramways of this capital. Twenty-four wagons laden with railroad materials are now en route to Morelia, where Sullivan's engineers have finished their surveys and are ready to commence the construction of that branch of the road.

By telegraph the announcement has been made that the engineers sent out to survey the Palmer-Sullivan route from the Pacific Coast, via Colima eastward, reached the Port of Manzanillo on the 19th ult., and commenced their labors within twenty-fours after their debarkation. *La Tribuna* gives their names as A. C. Preston (chief), C. W. Haynes, W. D. Heston, S. S. Steff, J. C. Patterson, W. L. Sepumes, W. G. Davis and W. B. Dixon.

Last Thursday Mr. Sullivan invited some Mexicans to visit the Toluca road and gave them a *déjeuner à la fourchette* on the plain of Salazar. Among the guests were ex-President Diaz, General Trevino (Minister of War), General Riva Palacio, Señor Dr. Ortega, Dr. Labrun and other celebrities. They visited also the camp of the American engineers and eulogized not only the road bed, but the talent and enterprise of the Sullivan-Palmer Company, present and resident in the United States.

Almost the entire American colony was at the Legation last week. There were some distinguished foreigners and several agreeable Mexican families present. The young people seemed to enjoy the dancing and those Americans who have but recently arrived certainly appreciated this opportunity of meeting their compatriots.

There is much enthusiasm in Chihuahua about the new road to Paso del Norte.

Captain Nutt and other engineers of the Central Railroad has been surveying in Paso del Norte. The line is now laid down from Mexico to Huehuetoca, and will soon be so as far as Salto.

A company of American capitalists have offered $1,500,000 to Messrs. Aguayo for the gold mine of Mulatos.

The *Siglo* states that an American company, "La Quintera," has bought the Rosario mine for $30,000. Mr. Shepherd has bought two mines, and several other purchases will soon be concluded.

The engineers Anginano and Romo have been commissioned to determine the boundaries of Guanajuato and Talisco, and the geographical portions of the cities in the two States.

A new telegraph line will be established between Morelia and Puruandiro, with eventual extension.

The engineers of the Sullivan-Palmer enterprise have two picturesque encampments, one at Huisquilucan, and the other at Jajalpan.

The cars are running on 17 kilometres of the Hidalgo railroad, from Pachuca to Xochihuacan.

Guerrero and Matamoras are now joined by telegraph.

RAILROADS—CENTRAL AMERICA.

The *Diario de la Guiara* states that Mr. Pyle has concluded arrangements for a line from Puerto Cabello to Valencia (Venezuela).

Arrangements have been made for putting up a line of telegraph between Trujillo and Carache (Venezuela).

The Venezuelan government has ordered the construction of a canal to join the Temi and Pinichin rivers.

ENGINEERS' SOCIETIES.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

President Francis occupied the chair at the regular meeting, held on Wednesday evening. The meeting was devoted to business. The following were elected members: Nathaniel Webster Ellis, Civil Engineer, Manchester, N. H.; Louis Randolph McLain, Resident Engineer, Richmond & Alleghany R.R., Buchanan, Va

The proposed amendment to Article XIX. of By-Laws, requiring an affirmative vote of at least four-fifths of all the votes cast as necessary for an election, was lost; amendments to Articles V., XXII., XXX. and XXXI. of the Constitution were adopted. The next annual convention is to be held in Montreal, Canada; time and arrangements were left to the Board of Directors. The Board of Directors was also requested to consider what action the society should take in reference to the proposed World's Fair of 1883.

At a date to be soon announced, Lieut. Commander H. H. Gorringe, U. S. N., will read a paper before the society upon the "Removal of the Obelisk from its Site in Alexandria, Egypt, to its Site in the Central Park, New York." This paper will be fully illustrated, and special arrangements will be made for the accommodation of members and guests.

LIVERPOOL ENGINEERING SOCIETY.

The hundred and fourth meeting of this Society was held on Wednesday evening, 19th ult., at the Royal Institution, Mr. A. Holt, President, in the chair. A paper was read by Mr. C. F. Findley, M.A., C. E., of the Dock Yark, Liverpool, on "The Design of Movable Bridges."

After enumerating the different types of bridges made use of in different localities, and describing the advantages and defects of each type, the author proceeded to discuss the comparative merits of swing bridges constructed in one leaf and in two, advocating the single-leaf system, on the score of economy, up to a limiting span dependent on the proportion of the moving load to the dead load. He then investigated the ratio which the tail end of the bridge should bear to the total length to make the cost the smallest, and described methods of determining the strains on the continuous girders of a single-leaf bridge, which were illustrated by diagrams. The paper was further illustrated by sketches of a bascule bridge, a drawbridge and a single leaf and a double leaf swing bridge.

A discussion followed the reading of the paper, and the further discussion was adjourned to the next meeting, on the 2d of February.

THE PROSPECTS OF THE PANAMA CANAL.

A dispatch sent from Paris, Jan. 31, to the London *Times* says: "The report which M. de Lesseps will read to-day at the first constitutive meeting of the Panama Canal Company states that the subscriptions resulted in applications for 1,200,000 shares, of which France subscribed for 994,508 shares. Seventy engineers, superintendents and doctors have been sent to the Isthmus. Steam engines have been ordered which will permit of the employment of a number of day laborers, not to exceed 8,000. The entire capital required amounts to 600,000,000 francs (about $120,000,000), only 300,000,000 francs (about $60,000,000) of which have been called up, the remainder to be covered by the issue of obligations."

AMERICAN APPROVAL ASSUMED.

PARIS, Jan. 31.—The meeting of the Panama Canal Company to-day was largely attended. Stock to the amount of 317,000,000 francs (about $63,400,000) was represented. The report of M. de Lesseps was read. It seeks to show that the Nicaraguan Canal is practically an impossibility. It declares that a complete agreement has been arrived at with the United States in regard to the Panama scheme, the only proviso being that the neutrality of the canal shall be assured. All the resolutions proposed were unanimously adopted. The next meeting will be held on March 3, when the progress of the works will be considered.

THE DESIGN GENERALLY OF IRON BRIDGES OF VERY LARGE SPAN FOR RAILWAY TRAFFIC.

BY THOMAS CURTIS CLARKE, M. A. S. C. E.; M. INST. C. E.

(*Continued from page 48.*)

Mr. W. H. BARLOW, Vice-President, said, considering the long list of American girders of great span erected since 1870 exceeding 300 feet and reaching 515 feet, he thought English engineers might look with envy upon their American brethern, in having such numerous opportunities for the exercise of their professional skill. In the author's description of the method in which Mr. Linville had erected the bridge over the Ohio River, and of the manner in which Mr. Shaler Smith had erected the bridge over the Kentucky River, there were examples of facilities of resource in American engineers which both the older and younger members of the profession might follow with great advantage. In large spans it was a matter of considerable importance to study the details of the structure. There was undoubtedly a considerable difference in the use of what the author called pin-connections as compared with rivet connections. He had, to a certain extent, looked into that subject, and he found that in suspension bridges there was a surplus of metal of about 10 per cent. arising from the use of pin-connections, while in riveted girders the waste amounted to 30 per cent., so that there was a large saving in the former method. It was to be observed, however, that a pin-structure, which was a joint, was liable to motion, and he was not quite sure whether in point of durability it was as good as the other. The sixteen bridges mentioned in the author's tabular statement might be arranged under four classes: (1) what he had termed quadrangular bridges with pin-connections; (2) containing one bridge, Mr. Brunel's, at Saltash; (3) lattice bridges; and (4) tubular bridges. He had endeavored to compare the efficiency and structural merit of those bridges by the system of ascertaining their limiting spans. It was a mode of treating the subject which he had adopted some years ago. It was first published by Prosessor Rankine, and it afforded great facility in ascertaining what the weight of a girder should be without the trouble of calculating all its several parts; and in like manner it afforded the means of computing how far one girder was superior to another. He meant by the limiting span the length to which a girder could be carried, increasing all its proportions in like manner, when its own

weight would produce upon it the strains which were said to arise in the girder itself. Or it could be carried a little further, by ascertaining the length to which the girder might be carried so as to bring upon it those strains which English engineers were in the habit of putting upon girders—5 tons tension and 4 tons compression. With regard to the quadrangular girders mentioned in the list, the first of them had a limiting span of 901 feet, and the others had limiting spans of 952 feet, 855 feet, 858 feet, 852 feet, and 982 feet, giving an average of 900 feet. The last girder in that group was number 16, and he desired to make a remark upon it. It was referred to in the paper as being one of the best girders. It was one of Mr. Linville's girders, and it was evident that he was a clever constructor; but, judging the girder in question by its limiting span, it did not appear to possess the same merit as the others. He thought, however, that that was not due to the girder itself, but to the manner in which the live load had been stated in the paper, for, whereas the live load of the other girders of Mr. Linville's had been stated at 3,000 pounds to the foot, that was only put at 1,818 pounds, although in another part of the paper it was referred to as 3,000 pounds. Taking it at 3,000 pounds to the foot, that girder also came up nearly to the limiting span of 900 feet. He therefore came to the conclusion that the limiting span of girders of that construction was 900 feet. The next bridge, Mr. Brunel's, was of an early date, but in that case the limiting span was also 900 feet, or rather 1 per cent above it. It was a bridge of very large height in proportion to its span. It might be said to be on the quadrangular system, inasmuch as the ties were at an angle of 45°, and it was pin-connected. It was known to many engineers that Mr. Brunel used in that bridge certain chains which had been previously made for a suspension bridge, and thence arose the pin-connections. This bridge undoubtedly ranked quite on a par with the best American bridges. In the next set, the lattice, it appeared that there was, as compared with the quadrangular system, large waste of metal, apparently amounting to from 40 to 46 per cent. In the tubular bridges the result was still less favorable, and it appeared that nearly two-thirds of the weight might have been dispensed with; but it should be remembered that it was in tubular bridges that the first attempt was made to introduce wrought iron in large spans upon railways. That was done by the late Mr. Robert Stephenson at a time when perhaps it would not have been in the power of any other man to introduce wrought iron in such structures. He had, without exception, the best knowledge of mechanics and of structures of any man of his time; but that was thirty years ago, and great progress has since been made, which he believed was represented by the fact that the use of the structural knowledge possessed at the present time would have effected a saving of two-thirds of the metal used in those bridges. In making these remarks he relied upon the figures given in the paper, and he was quite sure that the author, while undertaking the great labor of collecting the facts, had done his best to secure accuracy. But it was possible that some errors might be included, and it appeared to him that the "live load" stated to be carried by the girders should be further examined; because it was a material element in the calculations, and because in several cases the amounts put down under this head exceeded considerably the estimate of "live load" generally used in this country.* Before leaving this part of the subject it was proper to refer to the works of Sir John Macneill, who, as early as 1843, erected an open-work girder of of wrought-iron of 84-feet span. His principal work of that kind was the Boyne bridge, designed in 1851 and completed in 1855, under the superintendence of Mr. James Barton, M. Inst. C. E. It was a girder covering three spans, the centre opening being 264 feet, and the depth one-twelfth of the span. The bridge was open trellis work of great merit, in which full advantage was taken of the principle of continuity. In this bridge, if the transverse girders and horizontal bracing were taken as load, not contributing to vertical strength, the limiting span exceeded 800 feet.

With regard to the author's observations upon steel, he did not think such careful consideration had been given to that material as to wrought iron. The days had gone by when it was possible to talk of the uncertainty of the strength of steel, it being used for all those purposes in which the greatest certainty of strength was required—wheel tires, rails, boilers, shafts, wire ropes for suspension bridges, ship-building, and the like. If it could be employed for these purposes, why should it not be used for railway structures? The author had spoken of it as being uncertain in its modulus of elasticity; at the same time he referred to the modulus of the elasticity of iron as varying from 20,000,000 to 28,000,000. He thought there must be something erroneous in the experiments upon iron. He had himself made many experiments upon iron, and he had never found so great variation in its modulus. The average was about 28,000,000; it varied only a little above and below that amount, and he thought there must be something wrong in the apparatus which gave so low a result as 20,000,000, unless it was wrought iron. Steel varied from 29,000,000 to 31,000,000 in its modulus of elasticity. He had made numerous experiments upon steel, and he could attest without hesitation that in that respect it was one of the most reliable materials. There was a difference between elasticity and brittleness. The modulus of elasticity meant the degree to which a material would extend in proportion to its length by a given strain: and the modulus in steel, whether it was hard or soft, lay between the limits of 29,000,000 and 31,000,000. Steel had been so far recognized in this country that the government had authorized its use in railway structures, assigning it a co-efficient of strength of 6½ tons to the square inch, that of iron being 5 tons; in other words, steel was regarded as a material possessing 30 per cent. more strength than iron. The Admiralty had made the same allowance for shipping, giving steel the same superiority of strength of 30 per cent. The Dutch engineers also credited steel with a co-efficient 30 per cent. higher than iron. Applying to steel the question of the limiting span the 900 feet at once rose to 1,200 feet, and then the reduction of the weight of the material became considerable. But he did not suppose that steel would realize that full difference of 30 per cent. with regard to the limiting span. Those parts which were in compression would probably require more material about them to prevent buckling, when they were subjected to a strain of 6½ tons, than if they were of iron subjected to a strain of 5 tons. He thought it quite probable, that a limiting span of 1,150 feet would be realized. Assuming that to be so, the use of steel was of great importance in large spans, say above 600 feet. At 600 feet there would be as great a difference in the weight of the girder by the use of steel as compared with iron as existed between the new American and the old-fashioned English construction. That was a matter of so much importance that he hoped it would be taken up by the author. He observed that the paper made no reference to archiform bridges, like the St. Louis bridge, with three arches of steel, and a bridge in Spain of 600 feet span, nor to several large suspension bridges. He understood, however, that the author had not included those structures, as it would have been difficult to comprise them all in one paper.

MR. BENJAMAN BAKER said the Institution was fortunate in having a paper of that kind from so distinguished a bridge builder as Mr. Clarke. For some reason or other, the American type of structure had not found favor in England or in Europe. About a fortnight ago, a continental builder had offered him some American bridges, and when he mentioned the difficulty of finding a market for them in this country because of the prejudice against the type, the builder replied that they had been offered all over Europe, without a purchaser being found. There seemed to be no reason for this prejudice, except, perhaps, that girders of the American type required to be very carefully manufactured, especially in the eye-bars. Of course, if they had come from the author's works, no one would hesitate to rely upon them; but a few bad welds would make an American bridge a very dangerous and treacherous structure. The author had compared the Ohio bridge and the Kuilenburg bridge, much to the disadvantage of the latter. He thought that the author had unintentionally done injustice to the Dutch engineers. The strain of the Dutch bridge was stated to be 6½ tons to the square inch. Of course, no government would admit that strain, and there was no doubt some mistake in the figures. Again, the rolling load was taken at 595 tons. It was a double-line bridge, and no continental government would consider that a satisfactory test for such a bridge of 492 feet span. That the test load was greater was proved by the deflections given in the author's table. As 3.05 inches (the deflection under the dead load) : 3,890 tons : : 1.32 inch (the deflection under the live load) : 1,250 tons, and not 595 tons as stated in the paper. The author appeared, therefore, to have under-estimated the rolling load by one-half. With that correction the Kuilenburg bridge, including the platform, carried about two and a half times the weight of the Ohio bridge, and the ironwork weighed barely twice as much; so that after all the Dutch bridge was not so much behind the American. He thought that since Mr. Colburn's paper had been read,* there had been a great assimilation between American and European practice, and in no point more than in the strains. Mr. Shaler Smith had sent him a specification of a recent bridge, and he observed that in the floor suspenders there was a strain of only 2 tons to the square inch, whereas in some of the early timber bridges on the Erie railroad the strain on the suspenders was 28 tons, and even after the bolts had failed and been replaced by stronger ones, as much as 17 tons was imposed. On the other hand, European engineers had approached the American in doing away with stunted box-girders and tubular bridges, and in adopting the open lattice type of bridge. The difference was now mainly between pins and rivet work. The author had claimed a number of advantages for pins, some of which he would allow, while others he would dispute. He said in one place that they were preferable on account of the mathematical certainty with which the strain could be calculated; but at the end of the paper he stated that the limit of error in the links was $\frac{1}{4}$ inch. Now an error of $\frac{1}{4}$ inch in a 10-foot eye-bar would mean a possible error in the strains to the extent of 1½ ton to the square inch. If, in a given group of eye-bars constituting the tension member of a quadrangular girder, the strain might vary + and — 1½ ton per inch, he was quite prepared to admit the result was near enough for practical purposes, but he should not term it "mathematical certainty" of strain. In rivet work $\frac{1}{4}$ or $\frac{1}{8}$ inch error would have no effect at all upon the strains. In the discussion on M. Gaudard's paper he had stated his opinion that rivets did not act as pins, closely fitting the holes but rather as bolts gripping the plates together.† He had also stated that, as far as he was aware, no girders had been tested to destruction in which more than three plates were piled one on top of another in the flanges, and he had said he should like to know what the ultimate resistance of such girders would be. Since that time he had had a couple of girders made, in order to decide whether in practice the rivets simply gripped the plates or whether it was really, as usually assumed, a question of shearing and bearing area. The girders were each of 20 feet span, 2 feet deep, with webs ⅛ inch thick; four angle-irons, 2½ by ½ inch, and flanges generally 8 inches wide. In one girder the top and bottom flanges were alike, five plates ⅛ inch thick; and in the other girder, the bottom flange had eight plates ⅛ inch thick and 5½ inches wide. He had tested them both, in order to see what the result would be, and found that it was just as he had anticipated; for up to a calculated strain of 14 tons per square inch in tension, there was no movement of the rivets. That they did not shift in the least, but gripped the plates together like so many bolts, or almost like a weld, was proved by the deflections and sets under successive strains which were relatively identical with those in solid rolled girders. If the rivets had acted as pins, offering a certain shearing resistance and demanding a certain bearing area, the deflections and sets would have been many times those observed, since the girders were of ordinary manufacture with punched holes and exhibited the usual irregularities in the spacing of the holes. The plates were reduced in number toward the ends for a central load, and the calculated shearing strain per square inch upon the rivets connecting the angle-irons with the flanges was identical with the tensile strain upon the latter. With a tensile strain of 14 tons, and a compressive strain of 10 tons per square inch, the permanent set was but 0.15 inch in the five-plate, and 0.22 inch in the eight-plate girder, quantities in each instance so small as to preclude the possibility of the rivets having shifted and taken a bearing in the irregular holes in the flange plates, for rolled joists and even steel rails took as proportionally great a set. He had invariably found that badly punched girders with the holes partly blind, and the rivets tight but not filling the holes, deflected neither more nor less than the most accurately-drilled work, but he had never before carried on the test to the failing point in girders with as many as five plates and eight plates. He was rather surprised that the girder with eight plates failed by lateral flexure of the top flange under a calculated pressure of a fraction over 10 tons to the square inch. That

* Since the paper was read and discussed the author has revised and made several corrections in the "Table of Tubular and Girder Bridges for Single-track Railways."—SEC. INST. C. E.

* *Vide* Minutes of Proceedings Inst. C.E., vol. xxii., p. 540.
† *Vide* Minutes of Proceedings Inst. C.E., vol. xxxi., p. 182.

seemed very low, because he had often tested rolled joists with flanges only 6 inches wide at the same span of 20 feet and they stood a strain of 0.18 ton to the square inch, or nearly double that of the wider riveted girder. In the case of the eight-plate girder at high strains, it became apparent that the plate nearest the angle-iron was doing the most work, though theoretically it should do the least, and probably the same was true of the five-plate girder. It would appear, therefore, to be unscientific and misleading to go into any great refinements in calculating the moment of inertia of an ordinary riveted girder, and it was clearly illogical, though convenient, to assume that rivets acted as pins when they really acted as clamps. The unsatisfactory character of the usual kind of girder calculations was not lessened by ignoring the fact of the great range in the modulus of elasticity. The author referred to a case where the range was from 20,000,000 to 28,000,000; but Mr. Bender, who had occasion to test "many thousands" of eye-bars, found the moduli of bars up to 40 feet in length, and from 1 to 14 square inches in area, vary from 18,000,000 to 40,000,000 lbs., and many other no less competent and scientific observers had noted great variations in the moduli of iron and steel. With regard to long-span bridges the author had stated that under no circumstances could the girder on the cantilever system be less costly than a suspension bridge with a stiffening girder. He was under the impression that in the "Long Island" (New York) bridge competition the cantilever bridge with a central girder carried off the prize; and that the design condemned by the author in the case of the bridge of 734 feet span, came out in the competition lighter, and a lower tender was made for its construction, than in the case either of the suspension bridge with a stiffening girder or the arch bridge. There might be some explanation of that, but he did not think that bridges should be compared, as the author had done, merely by taking the superstructure for certain distances on each side of the main span. Everything should be taken into consideration—foundation, anchorage, or abutments as the case might be. The cantilever bridge did not require the same anchorage as a suspension bridge; in fact, it did not necessarily require any anchorage at all, because it might be made to balance itself to a great extent. In the case of the arch bridge the iron for temporary use in erection ought to be included in the estimate. He should imagine that 400 or 500 tons would be required to erect the arch bridge. He had had occasion to design and estimate in detail several railway and other bridges of spans ranging from 600 to 1,000 feet, and had found that no general rule could be laid down as to the most economical type of construction. Each case required to be considered individually with reference to the local and special conditions before any conclusion could be come to by the engineer as to the most generally advantageous type.

Mr. E. W. YOUNG would confine himself to contesting the author's statement that a stiffened suspension bridge was the cheapest for carrying a load over a long span; his object being to direct the discussion into the theoretical consideration as to what was the best method of carrying the load, because the improvement of details could not be of much avail if an expensive method of construction were adopted. Fig. 1 represented an ordinary suspension bridge unstiffened, with an evenly distributed load. Calculating carefully the length of each bar in the structure with the strain upon it, multiplying the length of the bar by its sectional area or the strain upon it, which amounted to the same thing, and adding these quantities together, a sum was obtained which might be taken to represent the quantity of material in the chains and rods. If now the same load was carried by a system of inclined and horizontal tie-bars, as shown in Fig. 2, and a similar process was adopted as that applied to the system of Fig. 1, it would be found that the quantity of material in a structure of this form was exactly equal to that in a structure of the form of Fig. 1. Further, if the distributed load of Fig. 2 was concentrated in two places distant one-fourth of the span from the centre and carried by the bars *A B*, *B C*, and *C D*, as shown in Fig. 3, it would be found that the amount of material required to carry the load concentrated in these positions was exactly equal to that required for the same load distributed and carried as in Fig. 2, and, therefore, identical with that required for Fig. 1. Here he would observe that by constructing a diagram of the form of Fig. 3, and concentrating the load in the manner described, a ready means was afforded of computing the quantity of material in the chains and suspension rods of a suspension bridge, care being taken to add a proper percentage for eyes and other connections, thus saving the trouble of drawing out the whole bridge and calculating the strains in detail. Since the method of Fig. 2 was similar to that of Fig. 1, it was clear that if the load could be carried by a system cheaper than that of Fig. 2, the new system would be cheaper than that of Fig. 1, the common suspension bridge. Referring again to Fig. 3, it would be observed that the load at *B* was carried by the tension bars *A B* and *B H*, but the strut *E B* might be substituted for the tie-bar *B H*, and taking the same unit of strain per square inch on the strut as on the tie, the quantities in the cantilever *A B*, *B E* would be the same as those in the suspension bars *A B*, *B H*, since *B E* was equal in length to *B H* by construction. But if the load was placed closer to the pier, say at point *F*, there would be a shorter strut *E F*, as against the tie-bar *F H*, and consequently to carry the load at point *F* it would be cheaper to use the cantilever than the suspension system, though the contrary would be the case for a load at *G* on the centre half of the span. So that for a load carried at any point between the fourth of the span and the pier, it was cheaper to use the cantilever than the suspension method. For a distributed load the method shown in Fig. 4 would be more economical than that shown in Fig. 1. It was thus demonstrated that carrying by suspension was not the cheapest way of carrying a load between piers. He had not been taking into account the dead load of the structure itself; but if that were considered, it would be seen that the cantilever system had a still further advantage over the suspension, because the weight of the bar *B H*, Fig. 3, had to be entirely borne on the point *B*, whereas the weight of the strut *E B* was partly borne by the pier, only half of it coming on the point *B*. Then there was a further advantage in favor of the cantilever method when a live load had to be carried. The cantilever portion was rigid, while the suspension portion was yielding, and if any alteration took place in the loads, either in Fig. 2 or Fig. 1, the whole structure was deformed; therefore, when a moving load had to be carried it was necessary to introduce some method of resisting its distorting effect. Fig. 5 illustrated the carrying of a live load by suspension only. That, he supposed, would be

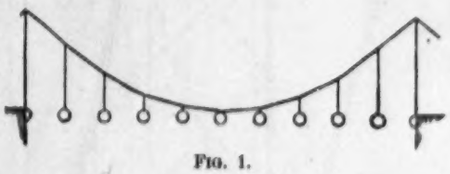


FIG. 1.

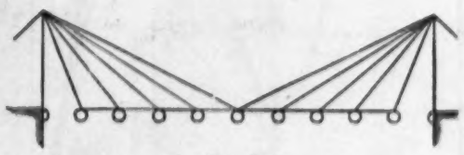


FIG. 2.

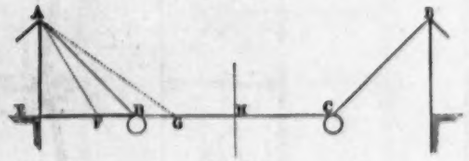


FIG. 3.

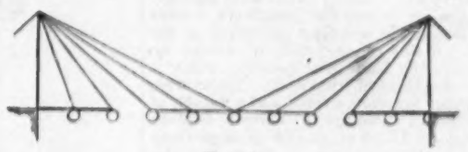


FIG. 4.

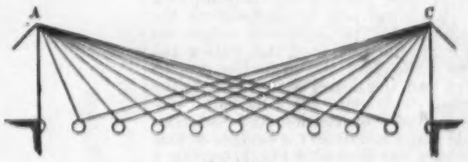


FIG. 5.

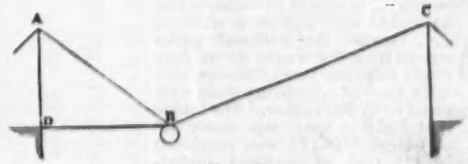


FIG. 6.

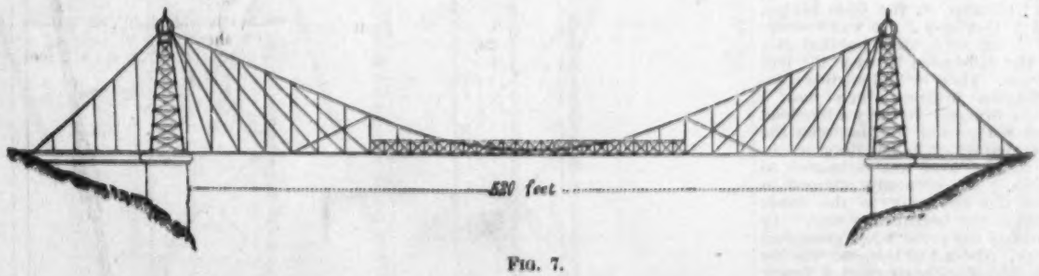
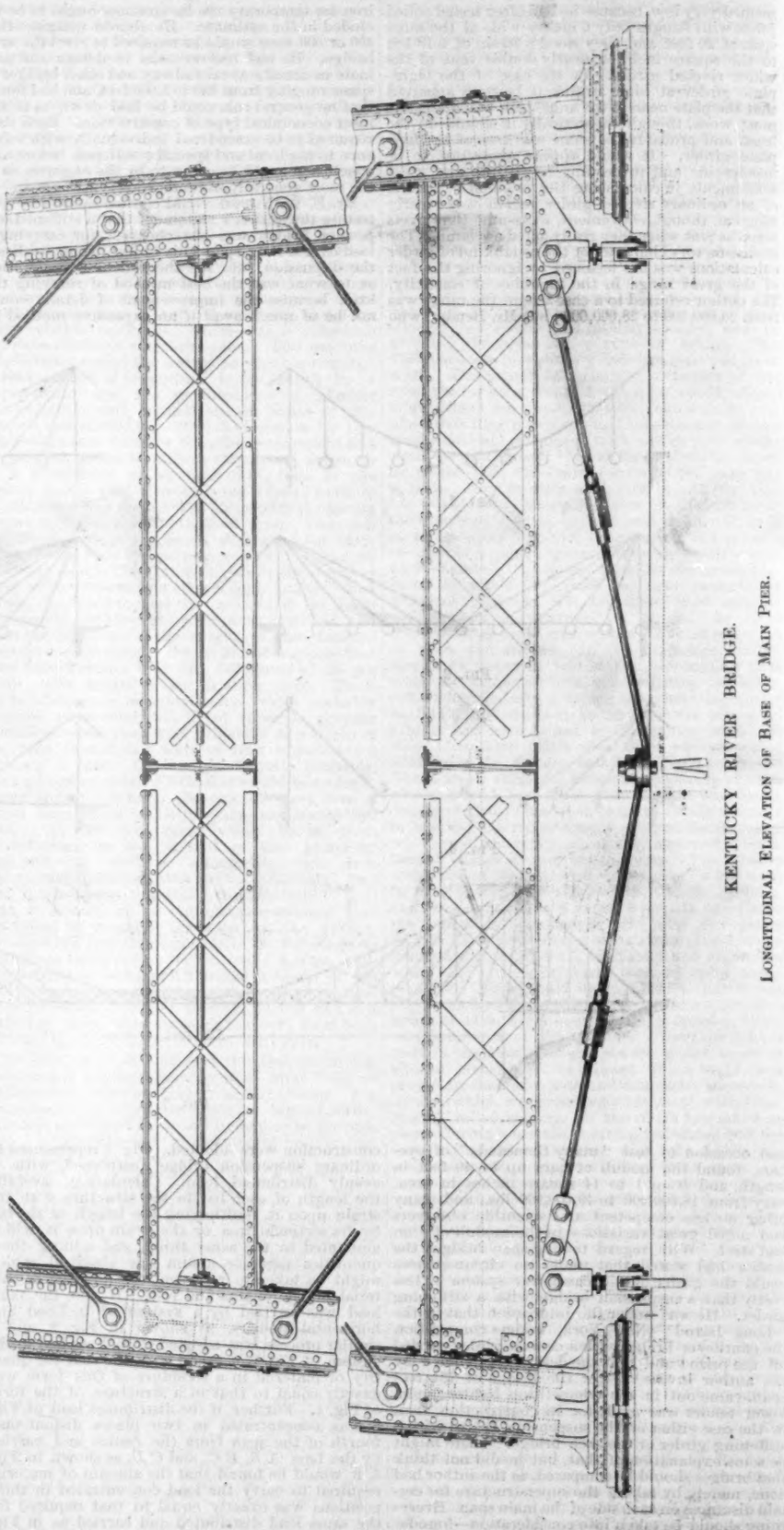


FIG. 7.

found as cheap a method as possible of carrying such a load entirely by suspension, *i. e.*, where the dead load was neglected. This method of carrying a distributed load took about 50 per cent. more material than that of Fig. 1 or Fig. 2, so that it would be a mistake to apply it to the carrying of dead load. An economical rigid suspension bridge could, he considered, be obtained by a combination of the systems of Fig. 2 and Fig. 5, the former being used to carry the dead load, and the latter the live load only. Using the system of Fig. 5, it would also be found that for portions of the load it was cheaper to use the cantilever system. In Fig. 6 he had shown a load suspended at *B*, one-third of the span from the pier, and he had found, by multiplying the sections of the material, or the length of the bars, by the strain, that precisely the same amount of material was required to carry the load at *B* by cantilever as by suspension; that was to say, the material in the bars *A B*, *B C* would be the same as the material in the bars *A B*, *B D*; therefore, if it were required to carry a live load so as to obtain rigidity, it would be cheaper to use the cantilever system for any load nearer the pier than one-third of the span; while on the other hand, it would be cheaper to carry the load by suspension when it was on the centre third of the span. There was, therefore, a point between a third and a fourth of the span in which a structure, to carry a load in the most economical form, should change from the cantilever to the suspension system; and the exact position of that point would depend, to a certain extent, upon the proportion between the live and the dead load. The greater the proportion of the dead load to the live load, the nearer the point should be to the pier; the larger the proportion of the live load the nearer should it be to the third of the span. For some years he had advocated that method of construction, and had consequently made many estimates for bridges of that kind, one of which was shown in Fig. 7, having a span of 520 feet. The result of his calculations had been to show that that system of construction was far more economical than that of a stiffened suspension bridge, because the stiffened girder formed a very serious item if it was to do its duty properly. He would mention two estimates that he had made with a view of comparing them with two bridges referred to by the author. The bridge shown in Fig. 7, of 520 feet span, was really 540 feet between the bearings, and it was estimated to contain only 441 tons of material, including the towers, anchorages, and everything, as compared with 1,176 tons on the Ohio bridge, which was of 515 feet span. It was true he had assumed that he was using steel, but that only compensated for the difference between the live loads in the two cases. Then he had made a comparison with Niagara bridge, which was a stiffened suspension bridge. To carry a live load of 500 tons it had 800 tons of iron between the piers; whereas a bridge which he had designed to carry 1,125 tons rolling load was estimated to weigh only 728 tons. The economy attained in these bridges was due not only to the mode of construction, but to the height of tower. In most suspension bridges the tower was a great deal too low for economy. About $\frac{1}{4}$ of the span was the most economical height if a cheap class of tower were adopted. That, in a great measure, explained the difference in the weight; and he was therefore all the more astonished at the author's figures. He had not given the chain the full benefit of the versed sine; he had not carried it to the bottom of the girder. He had also made the stiffened girder extremely shallow, $\frac{1}{75}$ of the span. It ought to be much less than that for economy; but even so he got less material in the stiffened suspension bridge than in the bridge on the cantilever system. With regard to Eads arch, it was the converse of the suspension bridge. Instead of putting a stiffening girder he stiffened the arch. He did not think it was so economical, because it conveyed a transverse strain to the arch, which then became subject to complicated strains. He considered that in a bridge of this character it would be best to make the arch of the most suitable form to resist compression, and to connect it with a well proportioned horizontal stiffening girder. Both arch and girders might be hinged at the centre of the span with safety. Again, means should be provided for preventing the hinge on the top of the pier from buckling outward or inward when the bridge was unequally loaded. If all that were taken into account it would materially increase the amount of material used in the Eads arch. It was quite possible to bruce bridges, of the compound character to which he had referred, by making the platform a horizontal girder laid on its side having points of contrary flexure at the junction of the cantilever and suspension portions, and splaying out the cantilever portion toward the piers. It was easy to make them stiff enough to resist the wind with safety. In every bridge designed by him 40 lbs. pressure per square foot had been allowed, and security obtained.



KENTUCKY RIVER BRIDGE.

LONGITUDINAL ELEVATION OF BASE OF MAIN PIER.

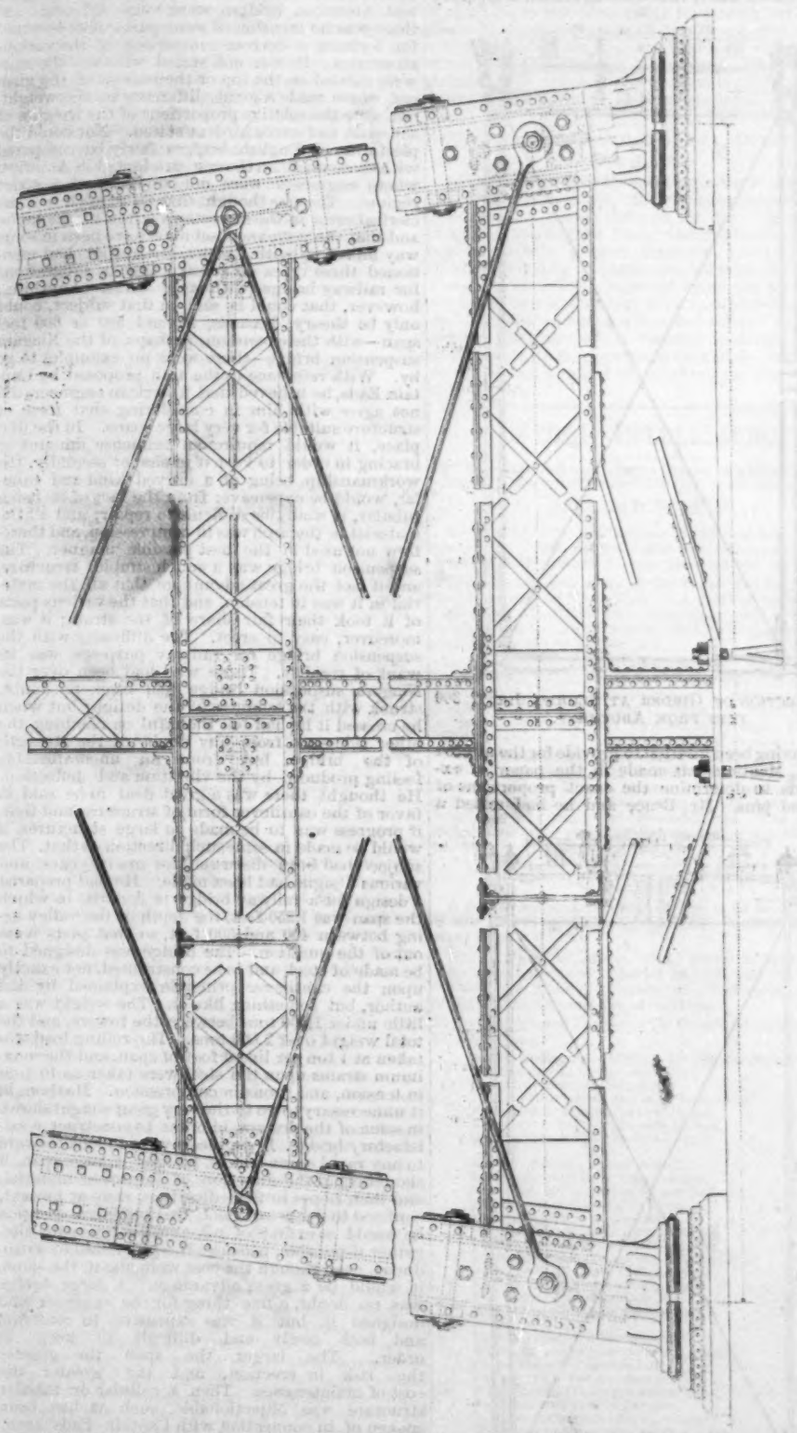
Mr. C. H. PHIPPS thought it desirable to draw a distinction between the designs of bridges in relation to their scientific construction, as completed *in situ*, and to such modifications as might be necessary for facilitating their erection. As regarded the first condition, he scarcely thought that either in the Kentucky bridge, No. 7, or in the Ohio

River bridge, No. 11, the construction was free from defect, as in both designs the introduction of vertical members between the booms was a wasteful use of material. When viewed, however, with regard to the remarkable manner of erecting the Kentucky bridge (by building out as a cantilever), it was perhaps necessary, and certainly convenient, to make the diagonal bars wholly tensile, and so to necessitate the use of the vertical pillars. In contemplating the economy of the above and other large bridges described in the paper, it would be noticed how much was due to the high proportion of depth to span in these girders:

In the Britannia bridge, erected in 1850, the ratio was	1-16
Boyne bridge, completed in 1855	1-12
Kentucky bridge, completed in 1877	1-16

When the Britannia bridge was built, the proportion of 1 in 16 was adopted as the most economical with sides of its massive construction, rendered enormously heavy by the great number of vertical pillars then thought necessary. The Boyne bridge was a great improvement and an admirable construction. Its lighter lattice sides admitted of an increase in depth, while their open construction offered less lateral obstruction to the wind. The Kentucky bridge, however, went still farther in height. The author spoke of the practice (now most usual in the United States) of constructing the booms of girders with assemblages of bars jointed with pins like the chains of a suspension bridge. This had been done to a large extent in the lower booms by Mr. Berkley in India, and with great advantage for celerity of erection and facility of carriage. At first sight this manner of constructing the booms of girders appears to be economical in weight; but from his calculations it was only so when the pins were more than 11 feet apart. He had calculated the conditions of the lower boom of the Charing Cross bridge, where the bays were 11 feet, with the result that, calling the utilized metal 100, the additional metal in cover plates and metal rendered ineffective through effect of rivet holes, amounted together to 40 per cent. To contrast this with the chain-link system, he had taken the proportion of excess in the head ends over the general body of the bar, as shown in No. 4 example of Mr. Berkley's paper "On the Strength of Iron and Steel,"* and he found that, when the length of bar was 4½ feet, the excess in the two heads was equal to the whole of the metal in the body of the bar; and that it was only when the length reached 11 feet that the percentage of losses on the two systems was about the same. This, of course, explained the necessity for economy of making the bars long (as mentioned by the author); but when this was done, it led to a difficulty in the increased length, and consequent weight of the rail-bearers, which was fixed by the distance asunder of the joints. On this and other points the want was felt of more detail of the construction of the American bridges. In reference to the building of very large bridges, he thought the best hopes were on the stiffened suspension bridge with the tensile portion of steel wire; and even in girder bridges he would throw out the suggestion to make the tensile boom of steel-wire cables.

Mr. MATHESON said the depth of the girders referred to by Mr. Phipps were now generally regarded as obsolete; a better knowledge of the materials had led to the construction of deeper girders. He had been surprised to find how shallow were the girders described, in comparison with those supposed to be usually adopted in America. It had been imagined that a great deal of economy had been obtained in the American system by having the proportionate depth to the length of the girders as 1 in 7, or even less, and it was rather a concession to English practice that, in the bridges brought forward as good types, the proportion did not exceed 1 in 10. That the saving in weight which deep girders allowed was well understood in England, might be seen by Mr. Brunel's bridges at Chepstow and Saltash; but then it was also well known that the advantages were counterbalanced by disadvantages. The question of pins *versus* rivets was a point on which the English differed from the American bridge builders. He was glad to notice that the author did not recommend pins for bridges under 100 feet span. There were numerous bridges in America of much less span made with pins—and many of them of what English builders would call a very loose style of construction. A few years ago pin-bridges were common in England, but he thought it was the opinion of the best engineers that, although for some years they might be as good as riveted bridges, and show a greater economy in construction, they were not permanently so good. The $\frac{3}{4}$ inch clearance recommended by the author would, in his opinion, with the pins, show in time much deterioration. The pins would be liable to hammer under railway traffic, while rivets would form part of the absolute structure, and in fifty years would, as at the beginning, form part of the solid iron. With reference to the construction of links, a few years ago a firm in London rolled solid links without welds, and he considered them to be the best that were ever made; but that firm no longer existed, and no one else had taken up the manufacture. He believed one or two firms had begun to make links without welds, and it would be interesting to know how they were made. In America, by a combination of the hydraulic forging-press and steam-hammer, they were made quickly out of simple bars; but the Americans possessed some advantages not shared in England. English manufacturers had to obey the instructions of numerous engineers; no manufacturer could tell what design might be presented to him next week. In America the designer and manufacturer were allied, and the manufacturer could afford to make thousands of links and lay them by, so that, when a bridge was wanted, it could be made in a few weeks. He did not say which system was the best; but, at any rate, it was a point that considerably affected the question under discussion. Economy could often be obtained by hauling over a girder, but a link-bridge girder could not be hauled over without special preparation, because the bottom member would collapse, while in a riveted girder it would temporarily form a strut. No doubt, however, in countries where there was no skilled labor, the facility with which pin-bridges could be put together on staging was a great advantage. The author had compared the weight of American gir-



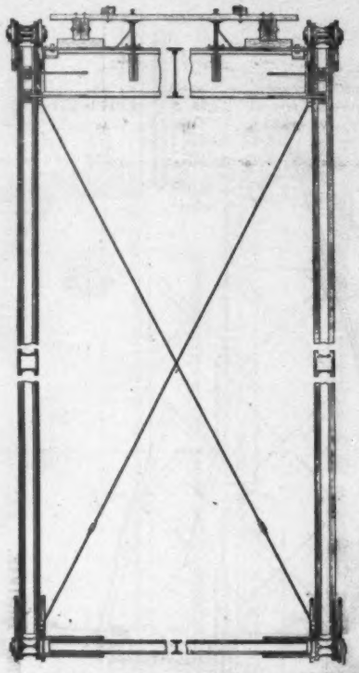
KENTUCKY RIVER BRIDGE.

TRANSVERSE ELEVATION OF BASE OF MAIN PIER.

* *Vide* Minutes of Proceedings, Inst. C. E., vol. xxx., p. 234.

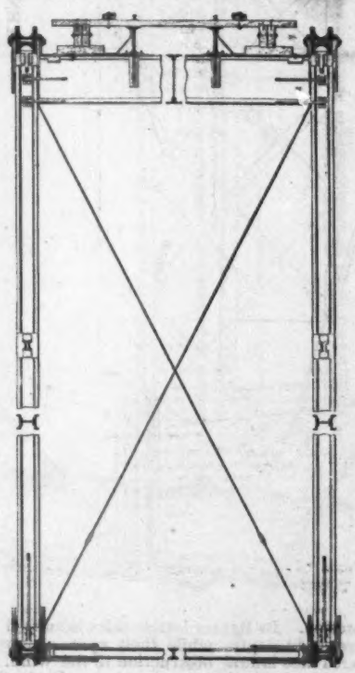
ders with the weight of English girders, to the disadvantage of the latter. No doubt the superior iron obtained in America allowed economy in that direction; there was also a saving by leaving out certain portions, the omission of which would be forbidden in England. The paper deprecated, for instance, such a waste of material as was involved in putting a platform on a bridge. That might explain the fact that trains in America often ran off the rails and fell through the bridge. He did not think any government inspector in England, Germany, or France would allow such a bridge to be constructed. A saving was also effected by omitting parapets, although such saving could hardly be put down to superiority of design.

Mr. C. DOUGLAS FOX thought those members of the Institution who had had the privilege of visiting America from time to time, during the last twenty years, would realize the rapid progress that had been made there in iron construction generally, and toward the solution of the important question now brought forward by one of the most prominent American engineers in that particular line of business. In 1857, iron bridges were in their infancy in America; but since that time they had greatly increased in numbers, and exhibited a marked improvement in their details. He thought it was a matter of congratulation for English engineers that, as the Americans had increased their knowledge and experience, they had drawn nearer to the English types of construction. The practice in America of advertising, not only for tenders but for designs also, would, he thought, take many years to introduce into England; and although there might be advantages in it in some directions, on the whole it would certainly not tend to an increase of scientific knowledge, or to an improvement in scientific construction. With regard to the question of pin and rivet construction, he differed from some previous speakers as to the feeling of English engineers. In his own office it had been the practice for the last fifteen years to adopt pin construction for spans exceeding 80 feet; and below that span to retain the ordinary rivet construction and plate girders. There were many advantages in pin construction, especially for very large spans. The exact amount and direction of the strains at every point could be more readily calculated, and the strains could be carried at each connection by a single pin, the strength and bearing surface of which could be proportioned to the total strain at that point, instead of their depending upon the joint action, and perfect fit, of a number of rivets, which, as experience proved, often did not all come into use until some of them had been unduly strained. This was the case even where holes were drilled and every care taken to fill them. A much worse result was naturally obtained where, as was too often the case, the holes were blind, or the rivets did not fill the holes. He must deprecate, as representing fairly the opinions or practice of English engineers, the view stated by a previous speaker, that such inferior workmanship made no practical difference in the strength or efficiency of riveted work. It had been said that that mode of construction was very defective, because dependent upon welds in the links. In all the bridges with which he had had to do of late years, he had never used a welded link for any important part of the structure. It was true that some years ago Messrs. Howard & Ravenhill were the sole manufactures of rolled links; but there were at present several firms in this country who were able to produce a solid link by stamping out the eye by hydraulic pressure. A number of links were then placed together, and the holes at both ends drilled to template, so that they exactly corresponded, and the links were interchangeable. He had obtained links thus manufactured at a less price per ton than riveted work included in the same contract. There was no secret about the process; it was simple, and the result was satisfactory. But if the system were to be adopted to advantage, he had found it important that joints in the flanges at the pins should be avoided, and that no rivet should be introduced into the links. Many bridges were constructed where the links, although mainly connected by pins, had rivets introduced in order to connect the eye with the body of the link. Mr. Bruce and he had tried some experiments upon the subject, and they had been much struck by the remarkable results produced. They took links which had a sectional area of 6¾ inches by $\frac{7}{8}$ inch in the body, some stamped out of the solid, and others having their eyes riveted on, and tested them in Kirkaldy's machine, the result being that, while the rivets reduced the area only by 13 per cent., they reduced the strength of the link by 30 per cent.; and while before the insertion of the rivets the iron was able to carry a strain of 22 tons to the square inch, after the insertion of the rivets its power was reduced to 16¼ tons. With reference to the supposed difficulty of rolling over girders of that kind, he could only say that a bridge not far from London, of 120 feet span, had been thus treated under his own direction, temporary



CROSS SECTION OF GIRDER AT SLIDING JOINT, 300 FEET FROM ABUTMENT.

struts having been inserted to provide for the altered strains. Mention was made in the paper of experiments to determine the exact proportions of links and pins. Mr. Bruce and he had tested a



CROSS SECTION OF GIRDER AT CENTRE OF CENTRE SPAN.

large number of full-sized links, pins, and struts, and he was interested to find that both these tests and the latest American practice very closely agreed with the results arrived at twenty years ago by the late Mr. Vignoles, Past-President, and the late Sir Charles Fox, after an elaborate series of experiments for the purpose of determining the proportions of the Kieff Suspension Bridge,* though these results differed essentially from previous practice. With regard to the construction of bridges of large span, the comparative table given in the paper did not appear to him to form a fair criterion. The ages of the English and American bridges were very different, and there was no mention of some particulars essential for forming a correct comparison of the various structures. It was not stated whether the rails were carried on the top or the bottom of the girders, which made a great difference in the weight, nor were the relative proportions of the weights of the main and cross girders stated. Nor could the platforms of English bridges fairly be compared with those made on the system adopted in America, where engineers were not under such a strict régime. Then he thought that there must be some clerical error in the deflections given in the table, and that the permanent set must have been in some way mixed up with them. The author had mentioned three types of construction as suggestions for railway bridges with large spans. Anything, however, that could be said on that subject, could only be theory, because, beyond 500 or 600 feet span—with the exception, perhaps, of the Niagara suspension bridge—there were no examples to go by. With reference to the arch proposed by Captain Eads, he believed that American engineers did not agree with him in considering that form of structure suitable for very large spans. In the first place, it would require an immense amount of bracing in order to keep it in shape; secondly, the workmanship, being of a curved kind and tubular, would be expensive; from the fact of its being tubular, it would be difficult to repair; and all the material in the arch was in compression, and therefore not used in the best possible manner. The suspension bridge was a much simpler structure, and it had the great advantage that all the material in it was in tension, and that the various parts of it took their fair share of the strain; it was, moreover, easy to erect. The difficulty with the suspension bridge for railway purposes was its want of rigidity. Those who had been over the Niagara suspension bridge had been, no doubt, struck with the boldness of the design; but when he crossed it he had felt thankful on reaching the other side—not from any doubt of the strength of the bridge, but from an uncomfortable feeling produced by the vibration and deflection. He thought there was a great deal to be said in favor of the cantilever form of structure, and that, if progress was to be made in large structures, it would be made in some such direction as that. The subject had been discussed for many years, and various designs had been made. He had prepared a design for a railway bridge in Austria, in which the span was 1,350 feet, the depth of the valley being between 400 and 500 feet, so that piers were out of the question. The bridge was designed to be made of steel, and to be constructed, not exactly upon the cantilever principle explained by the author, but something like it. The weight was a little under 1,600 tons between the towers, and the total weight over 2,000 tons. The rolling load was taken at 1 ton per lineal foot of span, and the maximum strains upon the steel were taken as 10 tons in tension, and 8 tons in compression. He thought it unnecessary to go to the very great weight shown in some of the designs in order to construct a satisfactory bridge. If engineers were to look forward to any rapid extension of bridges of large span, it should be in the direction of improved material, and their hopes in that direction, were at present, confined to the use of steel. On the general question he would say, first of all, avoid large spans altogether if possible, because, if a pier could be introduced, even though the cost were about the same, it would be a great advantage. A large bridge was, no doubt, a fine thing for the engineer who designed it, but it was expensive to construct and both costly and difficult to keep in order. The larger the span the greater the risk in erection, and the greater the cost of maintenance. Then a cellular or tubular structure was objectionable, such as has been spoken of in connection with Captain Eads' arch, and one that could not be easily got at and painted. Engineers ought also to avoid anything like a continuous girder. He had designed many bridges upon the continuous principle, but had come to the conclusion that the complication of strain resulting from its adoption rendered it undesirable for plate girders, and especially objectionable for bridges with pin connections. He had been much struck by the ingenuity of the arrangement of the Kentucky bridge and the way in which it was rolled over; but it would have been all the better if the girders had been separated over the top of

* *Vide* Proceedings of the Royal Society of London, vol. xiv., p. 139.

the piers instead of being hinged at intermediate points. It was most desirable to adopt sections which manufacturers could deal with without altering their machinery, and this it was quite possible to do. Another important point in dealing with large bridges, especially where there was no chance of getting an intermediate support for the girders during repairs, was that all the parts should be made so that any one could be removed and replaced while the structure was still standing. In that way the bridge could be renewed without the immense expense of re-erection. Last, but not least, steel should be used, or some better material if it could be found. He believed that after a time manufacturers would be able in the ordinary way to produce a steel, such as could already be obtained by extra care, equal to a working load of 10 tons per square inch in tension and eight tons in compression; and, when that was accomplished, there would be very little difficult in building bridges with spans of 1,500 or 1,600 feet, at comparatively moderate cost.

(TO BE CONTINUED.)

THE ASIATIC RAILWAY OF GENERAL BOGDANOVITCH.

The execution is actually begun of the grand project of a railway that shall unite China and the extreme Orient to the European system of railways.

A decree of the Czar of the 30th August (11th September) commanded that the construction should be proceeded with, with the least possible delay, of the Catherinenbourg-Tiumène line, one of the most important trunks of the great Siberian line. This trunk will unite the basin of the Volga to the Siberian rivers, hence its great importance.

The promoter of the project, Gen. Bogdanovitch, secured the imperial sanction for this vast enterprise in 1875, but the Russo-Turkish war and other events have delayed until now the definite commencement of its execution. At last, Count Loris Melikoff took the matter in hand, and the order was issued for the immediate construction of the above-named line. The project is said to be received with much enthusiasm in Russia.—*Translated from Le Technologiste.*

NOTE.

NEW ELECTRIC LIGHT.

A new method of producing light from electricity has been patented in England. Small balls of platinum or iridium are arranged at the ends of small platinum rods inclosed in pairs in the centre of a suitable globe, and a rapid succession of sparks is passed between them, whereby they are raised to incandescent heat. A disadvantage is the noise attendant on the rapid sparks.

SCALE IN BOILERS.

Engineering, after satisfactory laboratory experiments, and a practical test of eight months, recommends very highly the Disincrustant Marsellais, a compound manufactured by the Knowsley Works, Cheetham, Manchester, England, for the removal of scale in boilers. The makers claim for their composition that, after all scale has been removed from the boiler plates, a protective surface is formed, consisting of tannate of iron, which preserves the plates and does not allow any deposit to collect upon them. The only acids used are gallic and tannic acid, and the compound does not in any way affect the boiler fittings, as in the case of soda when used in excess.

GLOBES FOR GAS FIXTURES.

The amount of light absorbed by glass globes varies somewhat according to the nature of the glass. A plain glass globe absorbs from 10 to 15 per cent.; ground glass, from 25 to 40 per cent.; and opal, from 35 to 60 per cent. Determinations recently made with the globes now in common use, having large openings at the bottom and top, show that 26 per cent. of the light is absorbed by ground glass, and 55 per cent. by opal glass. One advantage of globes with large openings at the bottom is that some of the light escapes into the room through the opening, and if these globes were substituted for the old-fashioned ones with small openings, considerable would be gained. Aside from this, globes having small openings cause a flickering and smoky flame, by producing strong currents of air through the globe.—*Sanitary Engineer.*

AN ALUMINIUM BATTERY.

A curious and novel voltaic cell has been devised by Herr Wöhler, and described in *Liebig's Annalen*. The chief peculiarity is that both plates are of the same metal—aluminium—and a tolerably strong current is supplied. The cell consists of a glass vessel 6 in. high, filled with very dilute hydrochloric acid, or caustic soda, and containing an inner porous pot filled with concentrated nitric acid. In each compartment is placed a cylinder of aluminium provided with a projecting lug which passes through the cover of the vessel, and acts as a contact piece for the electrodes or conducting wires. As soon as the aluminium cylinders are plunged into the acids, a current is given off sufficiently powerful to heat a platinum wire red hot.

RECORDING AUTOMATICALLY THE DURATION OF SUNSHINE.

At the Greenwich observatory a very ingenious instrument is in use to record automatically the duration of sunshine through the day. It consists of a large, glass globe, hung within a hemispherical cup of slightly greater diameter, the cup being lined with a strip of paper covered with stencil ink. The globe is entirely exposed upon the roof, and, while the sun is shining, acts as a burning glass, and causes a continuous line to be made upon the paper. This line will be broken, however, as often as the sun's light is obscured by clouds, and thus a record of the amount of sunshine for the day will be obtained.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

A decree for over one million dollars has been entered against the Indianapolis Water-works Company, and a sheriff's sale is ordered to take place within forty days.

The artesian well, sunk by the Texas and Pacific Railroad Company at Elmo, Tex., is a marked success. At a depth of about 530 feet, pure, clear, soft water was struck in such quantities as to send an immense column running out at the top.

In response to the advertisement of Gen. Tompkins for proposals for constructing water-works at Fort Snelling, the following bids were received: Edward L. May, Faribault, $16,590; Horace P. Rugg, St. Paul, $23,800; Sylvester M. Casey and Tyndall Gwynston, St. Paul, $18,511: Harvey T. Dale and John H. Donan, Chicago, $13,975: Pendergast Bros., St. Paul, $20,023; Charles H. Robinson, St. Paul, $19,140. Gen. Terry awarded the contract to Dale & Donan, of Chicago, who have the contract for the construction of the head-quarters buildings, they being the lowest bidders. The contract includes all labor and material, including machinery, in the construction of the works

BRIDGES.

A double-tracked railway bridge is to be built over White River, at Indianapolis, Ind., within the next sixty days.

Mr. T. Munn, of Minto, Ont., wants a bridge over Pike Lake for his own especial benefit, and he has petitioned the County Council of Wellington for the bridge. The following is his petition:

To the Warden and Council of the County of Wellington:

GENTLEMEN—

A ploughman chiel tak'up his pen tae wish ye weel.
Lang may you toddle out an' in;
Keep free frae municipal sin.
Fou' be your barns, and may your stots
Hae routh o' turnips, hay and oats;
Your bits o' bairns, gin such ye hae,
Be free frae trouble nicht an' day.

An' ye wha dinna need to toil,
And force your livin' frae the soil,
May trade an' profits yield per cent..
Tae keep you cosie an' content.
And gin a doctor or a scribe,
You hae amang your worthy tribe:
I dinna grudge them fairish health;
But hope that ne'er get muckle wealth.
I always think whan they dae wull,
There's many lithers scant o' meat,
Bad physic and ancertain law,
Will quickly drive us tae the wa'.

Your servant, I. a favour want.
Which ye hae in your power to grant,
About the wilt dinnae ken,
But tak' ye a' for gentlemen,
Wha' justice gi'e to yin and a'
Be't close at hame or far awa,
In some outlandish corner, where
The roads hae aye been scant o' care.

'Tis for a place like that last named,
That for its pike has aye been famed,
I ask your help to build a brig,
Or ony ither kind o' rig,
To run me o' the twa mile roon,
When I gang tae Mount Forest toon,
Sae read my rythme, then freely give,
I'll pray for you as lang's I live.

I am, gentlemen,
Your weel wisher,
T. MUNN.

MINTO, Jan. 27, 1881.

Messrs. Manly & Cooper, 3,716 Sansom st., Philadelphia, are running full time and nights and are very busy. They have some small bridge railings, &c., to make; 2,500 ft. for Chicago and 4,000 feet of a very ornamental railing, to include their hand rail and base molding for the Filbert Street Elevated Road, now being built by the Pennsylvania Co.

STREETS, DRAINAGE, ETC.

The State of Florida has entered into a contract to drain Lake Okeechobee. This vast marsh, as well as the Okefenokee swamps, is located over one hundred feet above the level of the sea. Circular ridges of impervious limestone inclose these everglades, and hold the rainfall in a basin from whence it has no escape except by overflow or evaporation. If the rim of this basin be cut in several places this large area, said to contain 12,000,000 acres, will become productive, and it is well adapted to the growth of sugar-cane and rice.

RAILROADS.

The Sullivan Company has purchased the railroad from Zacatecas to Guadalupe.

Work on the Matamoras & Monterey Railway has been suspended since Juanuary 22, for some reason unknown.

The Barney & Smith Car Company, of Dayton, Ohio, have taken a $1,500,000 contract to build rolling stock for the N. P. R. R. Co.

The contract for Gould's Tunnel on the line of the P. C. & St. L. Ry., 7 miles west of Steubenville, has been awarded to Messrs. Patterson & Kearns, of Philadelphia.

The engineers on the Canada Pacific Railway have been notified that their services are no longer required by the government, in consequence of the construction of the line by a private company.

The experiment of running a locomotive without brakes has just been successfully tried by the Delaware, Lackawanna & Western Railroad Company. An appliance by which power was applied against the piston was used.

Over four and a half million pounds of railroad fastening, valued at about $140,000, have been sold at St. Louis the past few days. The supplies are to be used on the railroads now being constructed west of the Mississippi River.

A new railway company has been organized at Paris, Ill., for the purpose of constructing a road from the Indiana line to St. Louis, so as to form a direct connection with the road now under contract and pushing its work to the Wabash River.

On the Southern Pacific Railroad, of California, 340 miles of track were laid from Casa Grande, Arizona, to 35 miles east of Deming Station, N. M., in 12 months ended Jan. 25. The junction with the Atchison road at Deming will be effected about March 1.

The Canada Central Railway Company will increase the number of their locomotives, cars, etc., at an early date, owing to the increased traffic on the line. The receipts of the Canada Central Railway, since the change of gauge and the addition of the car-slip and ferry, are reported to have been over $100,000 in excess of similar period during any previous year.

The railway in Japan has progressed rapidly during the past year and is now completed to Sapporo, the capital of Yesso. The Japanese track gangs are led by American foremen and lay about a mile and a half of track per day. The trips over the newly constructed roads are very satisfactory. The low cost of building and the rapidity of construction bid fair to encourage additional attempts in this direction.

A Chihuahua, Mexico, newspaper reports that a number of persons, attracted to El Paso by the prospect of a speedy completion of the American railways, have crossed the Rio Grande. These immigrants are not of a desirable class, many being ruffians. An agent of the Central Railway has arrived at El Paso del Norte, who announced that work will begin in Mexico as soon as the Atchison, Topeka & Santa Fe Railway reaches the Rio Grande.

The mania for railroad construction within the borders of Indiana is certainly at its height. Seventeen surveying parties are now engaged in different parts of the State making surveys for new roads, surveys of old lines, and surveys which are to extend roads already built. In the eastern part of the State, a day or two ago, two surveying corps were at work on one farm, and had some difficulty in preventing the owner of the farm from arresting them for trespass. Probably five or six of the new projects will be pushed to completion.

In a few days active work will begin on the road from Palatka to Gainesville, Fla., while the Peninsular Railroad will be completed to the Ocala, in the same State, early in March; 3,000 tons of iron have been bought for building the Cape Fear and Yadkin Valley Railroad in North Carolina, and a new charter is to be obtained in Virginia for a road running into North Carolina and connecting with it when completed, then branching off from it at Fayetteville to the Carolina Central, following that line to Wilmington, and branching off again to Smithville.

RIVERS AND HARBORS.

It may require about two years more to complete the topographic and hydrographic surveys of the Mississippi.

The result of the surveys made so far by the Coast and Geodetic Survey furnish very important data for the River Commission.

WASHINGTON, Feb. 2.—The House Commerce Committee concluded the consideration of the River and Harbor Bill this evening. The total amount appropriated in the bill has not been summed up, but it is in the neighborhood of $10,000,000.

Levels have been run all the way from New Orleans

to Greenville, and bench marks established at certain intervals by the U. S. Coast and Geodetic Survey. These marks are determined with reference to the chief bench mark at Carrollton, and the elevation or depression of any point between there and Greenville may be readily ascertained. The line of levels will be continued to tide water, either down the river or across to Bay St. Louis.

The steamer Gedney, Lieut. Selbrey, engaged in the hydrographic survey, is taking soundings above Donaldsonville. The schooner Brisk is at Natchez. The Research has just completed the triangulation of the river between Baton Rouge and Bayou Sara, and will leave for Greenville to work toward Lake Providence. The Research takes the place of the steamer Baton Rouge, recently sunk. The steamer Barataria is between Lake Providence and Greenville, the party on board being engaged in triangulation. This division of the work has been completed as high as Vicksburg.

NEW PROJECTS.

The jetty system will in all probability be applied to Tampico.

The works on the Matamoras & Monterey Railroad have been inaugurated.

The Nassau Electric Light Company, of Brooklyn, capital, $250,000.—*Feb.* 1.

A railroad from Astoria to Northport, Long Island, is being discussed at 74 Wall street.

The Brooklyn City Ferry Company Capital $75,000, with power to increase to $1,000,000.

The Chicago *Times* of the 2d says that the Chicago & Atlantic R. R. is to be pushed vigorously.

The Colorado Central Irrigation Company, organized for the purpose of irrigating La Plata County, Col.

The surveyors of the Forest line, Vermont, railroad have still 14 miles to survey. The snow is four feet deep, and the party have to wear snow-shoes.

The Rochester & State Line Railway Company has filed articles of reorganization, at Albany, to be known as the Rochester & Pittsburgh Railroad, with a capital of $2,500,000.

The House of Representatives has passed the bill granting right of way to the Utah Northern Railroad through Montana, so as to make connection with the Northern Pacific Railroad.

The Kennebec framing company of Fairfield, Me., whose business is to furnish all kinds of frames for buildings, has been organized with a capital of $75,000 and ex-Gov. Coburn as president.

The Chicago, Milwaukee & St. Paul Railroad Company intends to build during the present year a line of railroad from Cedar Rapids to Council Bluffs, which will complete another trunk line between Chicago and Omaha.

Mr. J. C. Bailey, Chief-Engineer of the Toronto & Ottawa Railway, with a party of assistants, is busily engaged on the road five miles east of Norwood, Ont., finishing up the work. The whole party will move to Marmora in a few days.

The Central and South American Telegraph Company Capital stated at $5,000,000. To extend from New York to Texas, thence to Mexico, thence to South America. Jonathan Edwards, James A. Scrymser and Alfred Pell, all of New York, are the stockholders.

The corps of engineers surveying a route for the proposed Indianapolis & Springfield Railroad, in extension of the I. B. & W., reached Springfield, O., Jan. 26, from the westward, having completed the survey to the river at that point. Another line will be run soon by way of Tippecanoe and New Carlisle.

The Mutual Union Telegraph Company of Philadelphia, to construct, maintain and operate lines of telegraph throughout Pennsylvania. Capital of the company in Pennsylvania is $50,000, the remainder being held in New York, New Jersey, Maryland, District of Columbia, Massachusetts and Connecticut.

A company was formed about a month ago to build a line of railroad from Des Moines, Iowa, to connect with the Wabash Railroad at Albia, a distance of about 70 miles. It is understood that satisfactory arrangements for building the road have been made and that it will be completed probably during the present year.

The Genesee Valley Canal Railroad Company proposes to build its road forthwith, and the directors say that it will be ready for business next season. Already the chief engineer has advertised for 100,000 ties to be delivered immediately, and President Whitney assures the public that the work of construction will move right along.

The New York, New England & Western Investment Company gives notice that they are authorized to receive subscriptions for $500,000 of the capital stock of the Denver Railroad Construction Land & Coal Company, which is organized chiefly for the purpose of building and equipping the Denver, Utah & Pacific Railroad.

A rich deposit of mineral phosphate has recently been discovered on the island of Fernando de Noronha, 300 miles off the coast of Brazil. The concession to work the deposits is held in part by Americans, two of whom reside in Washington, and the government of Brazil is to receive $2 per ton for all the phosphate removed from the island.

The American Cable Construction Company, N. J. The incorporators are Denis Doren, Wager Swayne, Solon Humphreys, G. P. Morosini and A. F. Calif. Capital $1,000,000, and the company is empowered to lay ocean cables around the world. Denis Doren, President; G. P. Morosini, Treasurer; and A. F. Calif, Secretary. Books of subscription to be opened immediately.

The stockholders of the Burlington, Monmouth & Illinois River Narrow-Gauge Railway Company have elected the following officers: President, William Hanna; Vice-President, H. M. Lewis; Secretary, D. P. Phelps; Treasurer, J. T. Reichard; Directors, W. O. Cadwallader, Mills Lewis, J. T. Reichard and Samuel McFarland. The directors were directed to make this railway a standard gauge if thought expedient.

The Southeastern Railway has undertaken to carry out a new line of railway from Montreal to St. John, New Brunswick, by which the distance will be shortened nearly 500 miles. The route will be via Marieville, Sherbrooke, Agnes, and Bangor, the total distance being 270 miles. By the present connection the distance is 760 miles. Only 160 miles of new line is required to be built. Work will be commenced immediately.

A dispatch from Oconomowoc, Wis., says a force of 200 men are at work on the Madison line of the Northwestern Railroad between Milwaukee and Jefferson. Fifty-six pile bridges and three iron bridges, on the first fifty miles of the road, are in course of construction. The iron structures will be situated, one over the Kinnickinick River, one over the Fox River and the third over a highway in Waukesha. All will be completed in the spring.

A Paris (Ill.) dispatch of Jan. 26 says: A new railroad company was organized in this city to-day for the purpose of constructing a railroad from the Indiana line to St. Louis, so as to form a direct connection with the A. L. & St. L. road, now under contract and pushing their work to the Wabash River. The Board of Directors elected A. J. Hunter, President; George E. Lerings, Treasurer, and Geo. W. Fisher, Secretary.

A Rising Sun (Ind.) dispatch of Jan. 26 says: "Col. Horace Scott, accompanied by the chief of his corps of engineers, was here to-day prospecting for the proposed River Railroad between Cincinnati and Madison. A survey of the route is to be commenced immediately and will be completed in about thirty days if, after an estimate of the cost is made, the people along the line will aid the project sufficiently. Col. Scott will furnish the remainder of the funds necessary for the building of the road, and put it through immediately."

A despatch from Jerseyville, Ill., says: "There are three corps of engineers at work on the line of the St. Louis, Jerseyville and Springfield Railroad—one between Macounin Creek and Hodge's Creek, one between Hodge's Creek and Palmyra, and one between Morgan County line and Loami. The chief engineer will have the profiles and estimates ready to advertise for contracts by the middle of February. This road will be finished from Springfield to Jerseyville by the first of August next."

The Nassau Electric Light Company asked permission of the Brooklyn Aldermen on the 31st ult. to put its wires on poles, or in pipes, in all the streets of that city for 50 years. The certificate of incorporation of the company was filed with the Kings County Clerk the same day. The capital stock is $250,000, and the corporators are William B. Davenport, Charles H. Wheeler, George B. Abbott, John J. Hardy, Edwin H. Brown, Julius H. Kalley, Sandford W. Battershall, Robert W. Coffin and William H. Merrifield.

A prospectus has been issued in Paris of the Central American Submarine Telegraph Company, the object of which is to connect all of Central America with the United States and Europe by cable—with tributary land lines—to be laid from Belize to Cuba, Spain having granted a concession therefor. England will guarantee for a term of twenty years the payment of the sum of £1,000 annually (about $5,000) as the proceeds of government telegrams to and from British Honduras. The capital of the company is to be £120,000 (about $600,000.)

The Cincinnati Central Railroad Company, an organization which proposes to build a belt railway for connecting railways, and also an elevated railway for rapid transit to the suburbs, opened its books on the 29th ult. at Cincinnati, O. The stock was subscribed on the spot, and 10 per cent. paid in. The total capital is to be $1,000,000. A Board of Directors was elected and was organized by the election of Theodore Cook, President; Robert Simpson, Vice President, and W. Thrall, Secretary and Treasurer. The company already has a valuable franchise in the form of a right of way, and will soon begin work.

The Transcontinental Railroad Company filed articles of incorporation at Indianopolis Jan. 28. The incorporators are nearly all Indiana men. The railroad commences at Indianapolis and runs in a northwesterly direction through Marion, Hancock, Henry, Wayne and Randolph Counties, tapping the towns of Warrington, Newcastle, Dalton and Spartansburg, and terminating at the line between this and the State of Ohio—in all 75 miles in length. Capital stock, $1,000,000, a part of which has already been subscribed. Officers: Thomas J. Sprague, President; Amos D. Owens, Vice-President; Henry S. Sprague, Treasurer; Benjamin F. Bush, Secretary.

A new line is projected between Indianapolis and Chicago. It is called the Chicago & Indianapolis Air Line. The company owns a completed narrow-gauge, known as the Indianapolis, Delphi & Chicago road, running from Delphi, Ind., to Rensselaer. The grade of this road has been widened and the track is to be changed to a standard gauge. The company is now rapidly extending the road from Rensselaer in the direction of Chicago. The new company has already contracted for entrance to Chicago over the tracks of the Western Indiana. To summarize, the construction of less than twenty miles of road and the change of the Indianapolis, Delphi & Chicago from a narrow gauge to a standard gauge, with the necessary equipment, will give to Chicago a new eastern outlet and an air-line to Indianapolis.

The North Carolina Legislature is expected soon to incorporate the South Atlantic & Ohio Railway Construction & Operating Company. The capital stock of the company is to be divided into $100 shares, and cannot exceed in the aggregate $20,000,000. It is founded under the auspices of the Tinsalia Coal & Iron Company, of Virginia, who have been building a three-foot narrow-gauge road from their mines at Big Stone Gap, Wise County, Va., to Bristol, on the Tennessee & Virginia State line. They have also secured a charter to extend the line through Tennessee to the North Carolina & Tennessee State line, and now desire to extend the system of narrow-gauge railroads across the State of North Carolina to some convenient point on the Atlantic seaboard, and to bring it under one management from the Ohio River to the terminus on the Atlantic Coast.

The Chicago & Northwestern Company has contracted with various parties for the construction of about 500 miles of new road during the year 1881. Some of this mileage may be described as follows: A cut-off line from Milwaukee to Madison, about 80 miles; a branch from Madison to Montford, 60 miles, connecting the Chicago & Tomah narrow gauge, purchased last year, with the main line, and forming a through route from Milwaukee to Woodman and Galena; a branch from Henson, Dak., up the valley of the James River, the probable length being about eighty miles; a branch from the main line of the Dakota Division of the valley of the Sioux River; an extension of the Toledo & Northwestern, in Iowa, from Webster City to the Minnesota line, eighty miles, and a branch of the same road from Callahan to Lake City.

The several engineering parties who have been engaged in making surveys for the extension of the Indiana, Bloomington & Western road, by both the north and south lines, met in Indianapolis on Monday to compare notes and to arrange the specifications and plans of lines surveyed, preparatory to submitting them to the parties who propose to build the extension. As yet the surveys of either line are completed only between Indianapolis and Springfield, Ohio. By the northern line, which runs parallel much of the way with the Pittsburgh, Cincinnati & St. Louis, ten miles north of the latter, the distance is 132 miles, and the cost of grading it, with no grade heavier than thirty-five feet to the mile, will be less than grading the southern line, which will be 134 miles, two miles longer than the northern route; yet the southern route possesses some advantages, one of the most important of which is that should the L. B. & W. build a branch in Cincinnati there would be twenty miles less road to build, and they would avoid crossing the P. C. & St. L., and the Cincinnati, Hamilton & Indianapolis roads. Within the present month the location of the road will be definitely decided upon.

Articles of incorporation of the Duluth & Vermilion Railroad Company were filed in the office of the Secretary of State of Minnesota, January 28. The object of the company is the construction of a standard gauge railroad from Duluth, thence to some convenient point on or near Vermilion Lake, and thence to some convenient point at or near the northern boundary of Minnesota. The amount of capital stock is $1,500,000, in 15,000 shares of $100 each, to be paid in from time to time upon installments of not less than 5 per cent. upon calls authorized by the Board of Directors. The indebtedness is limited to $1,500,000. The members of the corporation are Geo. C. Stone, R. C. Mitchell, Wm. R. Stone, J. E. Knowlton and T. L. Blood, of Duluth, and A. De Graff and C. A. De Graff, of St. Paul, who are also the Board of Directors. The road is intended to develop the iron interests of the country it will penetrate. Parties are now engaged in making a thorough exploration of the territory to be reached by the road. The distance from Duluth to Vermilion Lake northward is 80 miles on an air line, but by road it will be about 100 miles. The articles of incorporation were filed for the purpose of applying to the legislature for a grant of swamp lands in aid of the construction of the road, which latter will depend entirely upon the result of investigations that will be made and concluded during this and the next year.

THE MARKET.

OFFICE OF ENGINEERING NEWS,
Friday Morning, Feb. 4, 1881.

Owing to the unusual severity of the winter, the almost impassable condition of our streets and the uncertainty of transportation both by land and water, there has been but little business transacted during the past two weeks, and it is probable this state will continue until the opening of milder and more settled weather. Prices remain firm at the quotations given in our last report.

The cold and snow have compelled an almost total cessation of building operations and a consequent dullness in the demand for building materials.

We shall give due notice of any important change in prices.